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Oldowan: Rather more than smashing stones

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Recent activities of the Italian Archaeological Mission at Melka Kunture (Ethiopia): the Open Air Museum Project and the GIS application to the study of the Oldowan sites

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PART I

Introduction

The site of Melka Kunture was discovered in 1963 by G. Dekker. The same year a French archaeologist, G. Bailloud, carried out the first surface surveys and collected important lithic materials and faunal remains.

Since 1965, a French-Ethiopian mission directed by Jean Chavaillon faced to the systematic investigation of the Palaeolithic site through intensive excavations in some of the archaeological levels and surveys of the large area occupied by prehistoric finds, the definition of the chronostratigraphy of the Lower and Middle Pleistocene sediments (Chavaillon, Taieb 1968; Schmitt et al. 1977; Cressier 1980; Wesphal et al. 1979) and the study of the lithic and faunal occurrences insofar put to light (Chavaillon 1968, 1973; Chavaillon et al. 1979). An interruption of field activities took place after the 1982 excavation campaign; in the following years, the study of a great part of archaeological materials discovered during extensive excavations and stored in the Melka Kunture Laboratory in Addis Ababa was nearly accomplished. Excavations in some Middle Pleistocene Acheulian sites of Melka Kunture started again in May 1993, under the direction of Jean Chavaillon.

Since January 1999 an Italian Archaeological Mission funded by the Italian Ministry of Foreign Affairs, the University of Naples "Federico II" and the IsIAO started a new project with the aim to publish previous works carried out at the site and to promote and organize the construction of an Open Air Museum (Piperno 1999).

The Italian Archaeological Mission at Melka Kunture has been organized in collaboration with Jean Chavaillon. Beside the Open Air Museum project, the main scientific purpose of this intervention concerns the reexamination of the archaeological, paleoanthropological and archaeozoological aspects of Melka Kunture, as well as the paleoenvironmental problems related to the geology, chronostratigraphy, volcanology, paleontology and palinology of the site (Bulgarelli & Piperno 2000; Berthelet, Bulgarelli, Chavaillon & Piperno 2001; Chavaillon & Piperno 2002).

The project will be realized in collaboration with specialists from the University of Naples "Federico II" and of Rome "La Sapienza", the French Universities of Bordeaux 1, Montpellier II, Clermont and P. et M. Curie, the Collège de France, the CNRS, the University of London and the University of Addis Ababa.

Melka Kunture

The prehistoric site of Melka Kunture extends for several Km along both banks of the high Awash Valley, 50 Km to the south of Addis Ababa. Its geological nature consists in a series of superimposed fluvial terraces with Pleistocene and Holocene sediments altogether reaching a thickness of about 100 m. A series of more than seventy prehistoric levels is preserved in these sedimentary and volcanic formations, dated from the Oldowan until the Late Stone Age (Fig. 1).

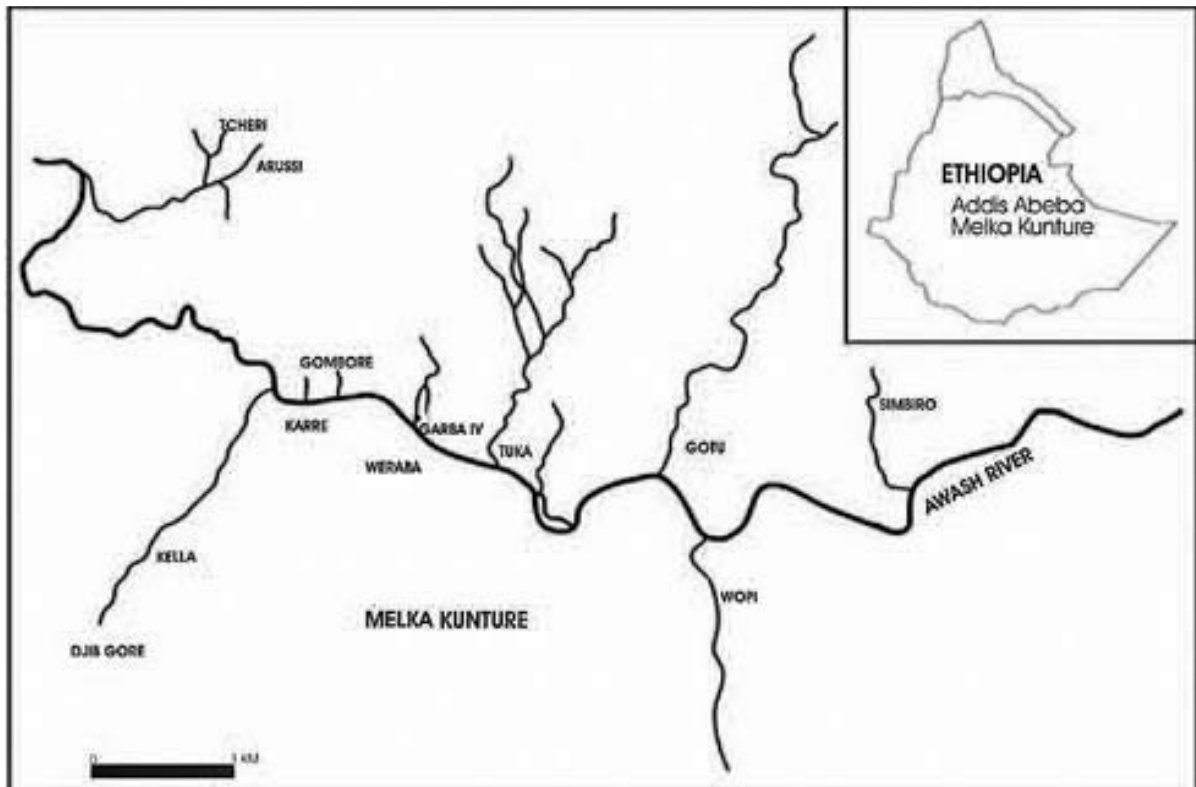


Fig. 1. Map of the main prehistoric localities of Melka Kunture.

Archaeological works carried out by Jean Chavaillon at Melka Kunture were focused to the exploration of some of the richest Oldowan and Acheulian levels. Excavations of large surfaces allowed to bring to light from 50 to 250 square meters for each site and to collect from 2,000 to 12,000 artifacts and faunal remains. The most important sites explored until now at Melka Kunture are the following:

Gombore I: An Oldowan site dated between 1.7 and 1.6 my (Fig. 2), very rich in lithic industry on pebbles (choppers, polyhedrons, rabots, etc.) and in faunal remains. A fragment of humerus belonging to *Homo erectus* (Chavaillon J. & N. 1969, 1976; Chavaillon et al. 1977) was found in this site (Fig. 3,1).

Garba IV: A Developed Oldowan site, comprised between 1.5 and 1.4 my (Fig. 4), where a large paleosurface (Level D) was extensively excavated since 1972 until 1982 (Chavaillon, Piperno 1975; Piperno, Bulgarelli 1975; Piperno 1977, 1986).

It yielded a very dense concentration of nearly 10,000 artifacts on obsidian and other volcanic rocks (Fig. 5) and over 2,700 faunal remains mostly of Bovids (*Pelorovis oldowayensis*, *Connochaetes taurinus*, *Damaliscus* cfr *agelaius*), Antelopes (*Gazella* sp.), Equids (including *Stilohipparion*), Suids (*Kolpochoerus limnetes*, *Metridiochoerus andrewsi*, *Phacochoerus modestus*), Hippopotami (*Hippopotamus amphibius*), Elephants, Giraffes, and a Primate resembling the present-day gelada [*Theropithecus* (*Simopithecus*)] (Geraads 1979).

Lithic material comprises very few roughly shaped handaxes mostly on flakes (Fig. 6), two cleavers (Fig. 7), several hundred of pebble-tools and a large amount of flakes and retouched flakes (Fig. 8). A child mandible related to *Homo erectus* was also discovered in the lowest level of the site (Fig 3,2).

Fig. 2. Melka Kunture. The Oldowan site of Gombore I before excavations.





Fig. 3. The hominid remains from Melka Kunture: 1) fragment of humerus of *Homo erectus* from Gombore I (Oldowan); 2) mandible of a 3/5 years old *Homo erectus* child from Garba IVE (Developed Oldowan); 3,4) parietal and frontal bones of *Homo erectus* from Gombore II (Middle Acheulian); 5): fragments of parietal and frontal scale of archaic *Homo sapiens* from Garba III (Final Acheulian-Middle Stone Age).

Garba XII: An Acheulian site dated to around 900,000 years, where a transitional Oldowan/Acheulian phase has been observed.

Gombore II: A Middle Acheulian site dated to around 700,000 years with several levels (Brahimi 1976). Two fragments of human skull related to *Homo erectus* (Chavaillon et al. 1974, Chavaillon, Coppens 1986) were discovered in one of these levels (Fig 3,3-4).

Fig. 4. The western Sector of the extensive excavation of the Developed Oldowan site of Garba IV D (Melka Kunture).

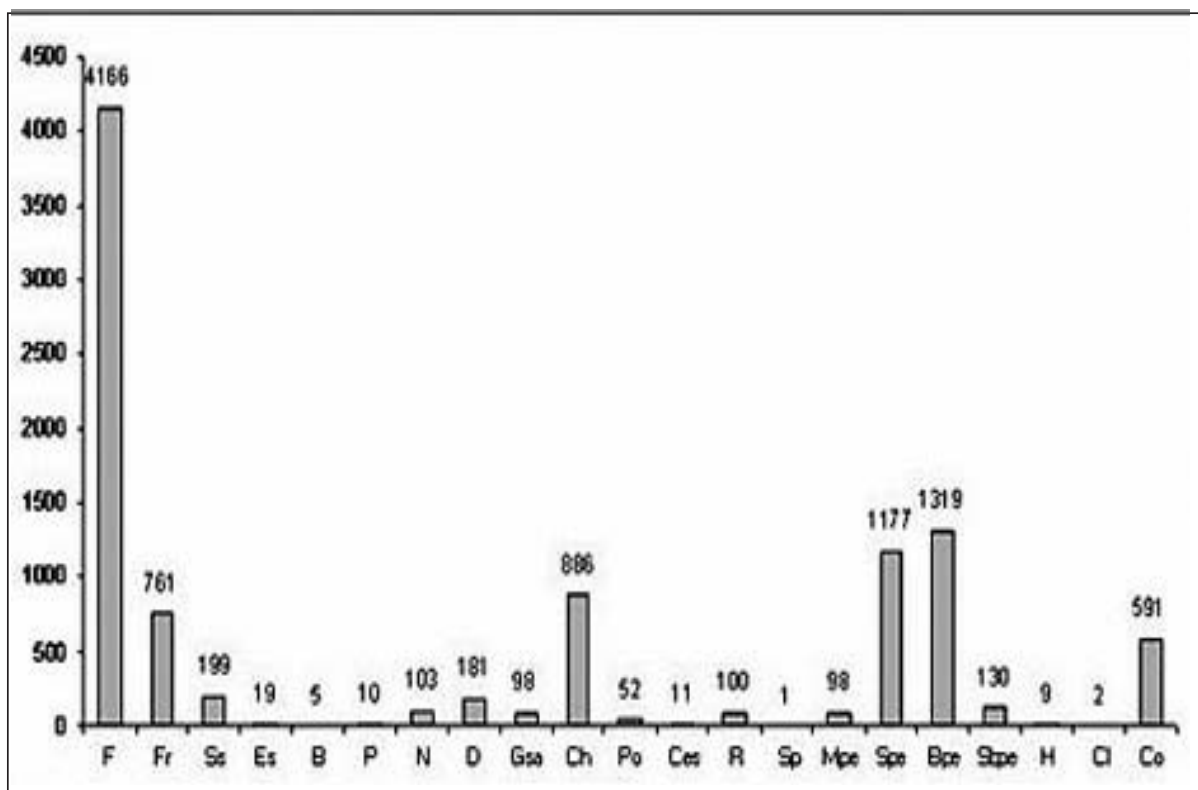


Garba I: An Upper Acheulian site dated to around 500,000 years, particularly interesting for the presence of hundred of handaxes associated to small sized flakes tools.

Garba III: A Final Acheulian site dated to around 250,000 years, which documents the transition towards Middle Stone Age, with the first presence of fossil human remains (Hours 1979; Chavaillon *et al.* 1987) attributed to archaic Homo sapiens (Fig. 3,5).

Kella: The site of Kella I is made up of volcanic-sedimentary formations with archaeological and faunal remains related to four main archaeological phases. Some artefacts referable to the Developed Oldowan were recovered at the base of the sequence; a Middle Acheulian complex was identified in an upper level. The Middle Stone Age is not well represented.

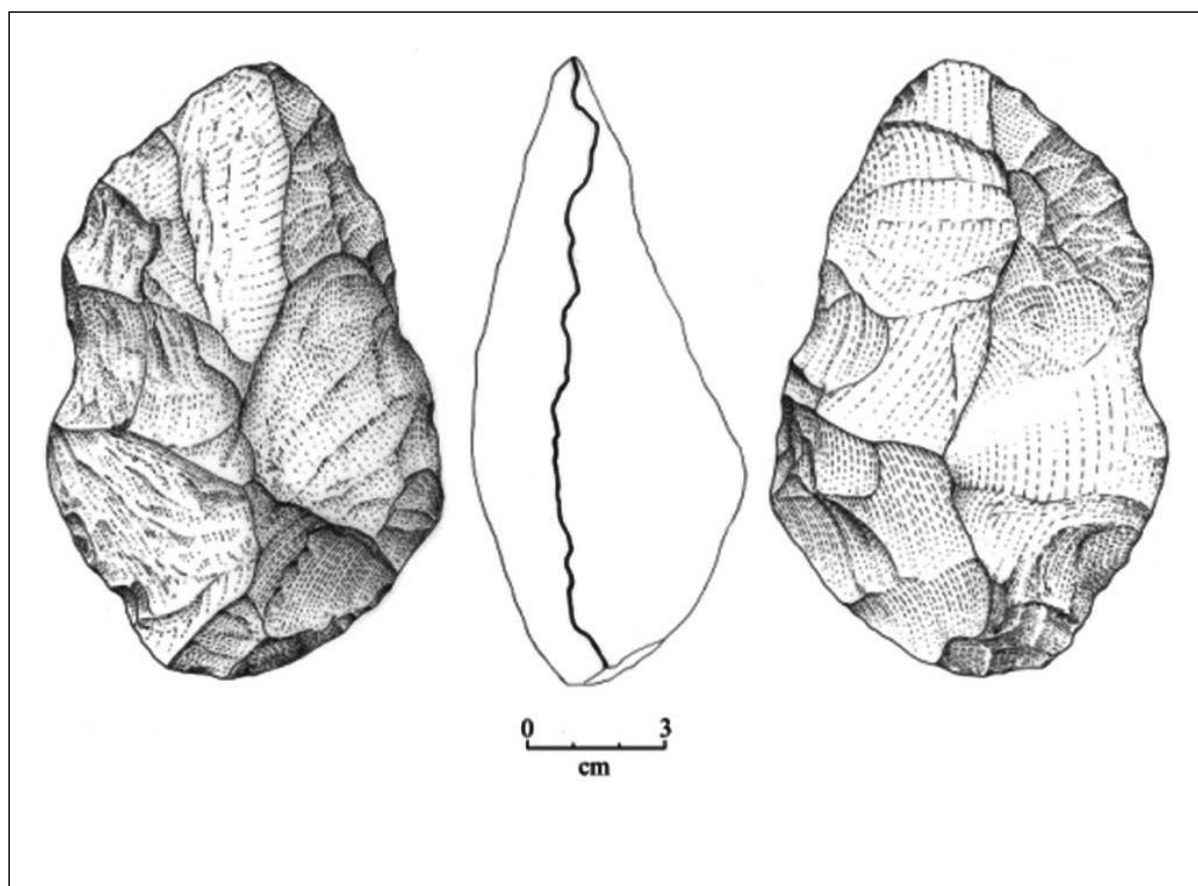
Fig. 5. Garba IV D: typological structure of the lithic industry. F/f: Flakes and fragments; Ss: Side scrapers; Es: End scrapers; B: Burins; P: Perforators; N: Notches; D: Denticulates; Ch: Choppers; P: Polyhedrons; Ces: Carinated end scrapers; R: Rabots; Sp: Spheroids; Mp: Modified pebbles; Sp: Splitted pebbles; Bp: Battered pebbles; SBp: Splitted and battered pebbles; H/Ph: Handaxes and protohandaxes; Cl: Cleavers; C: Cores.



Finally, at the top of the small hill of Kella, two partially eroded levels, where limited excavations were carried out in 1965 and 1970, contain in situ Late Stone Age materials. Lithic industry is characterized by numerous blades and bladelets, different kinds of burins and backed knives of Upper Palaeolithic type, notched and denticulates, borers, side-scrapers and small choppers (Makonnen Abye 1984; Hivernel Guerre 1976).

Balchit: During 2001 field season an important survey was conducted at Balchit, 6 km to the north of Melka Kunture (Berthelet *et al.* 2001). The site extends over several km(where large concentrations of obsidian flakes, blades, wastes and cores can be observed in different areas, some of them reaching an extension of more than 60 m with a thickness of more than 100 cm (Fig. 9).

Fig. 6. Garba IV D. Handaxe on a basalt flake.



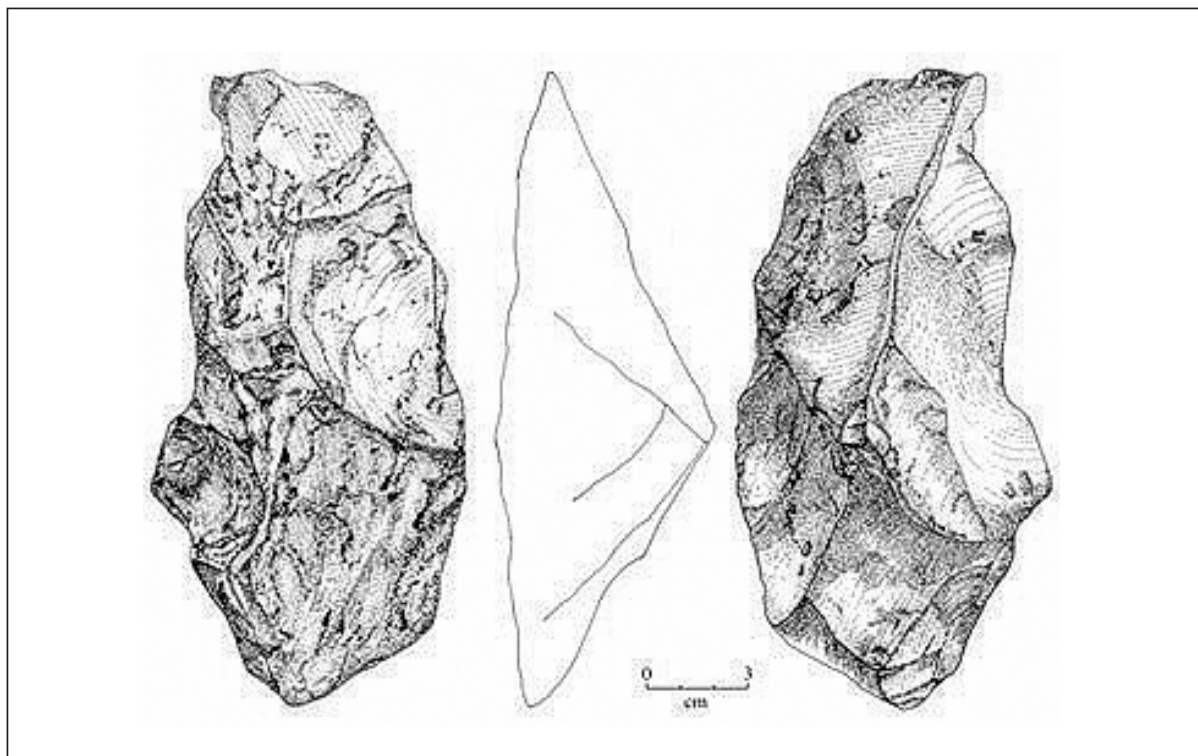


Fig 7. Garba IV D.
Cleaver on a large flake
(MK 7216). Basalt. 1:1.

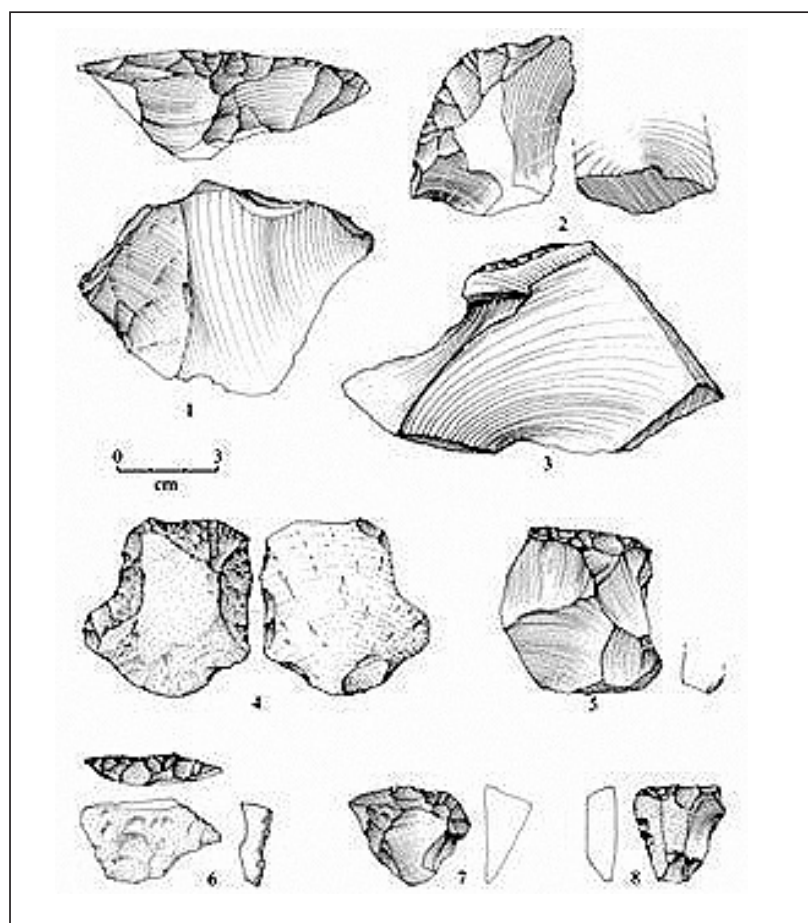


Fig. 8. Garba IV D. 1-8:
transversal side scrap-
ers (MK 6684, 6630,
4428, 8482, 3573,
6583, 7087, 9195). 1-
3,5-8: obsidian; 4:
basalt. 1:1.

Besides these accumulations there are more limited pit-like depressions, excavated by people trying to reach the veins in search of this raw material.

The site of Balchit has been repeatedly occupied during pre-historic times. The exploitation of obsidian occurred probably since the Late Stone Age until modern times. Analysis will show if the same sources were also utilized during Early and Middle Pleistocene at Melka Kunture.

The Italian Archaeological Mission at Melka Kunture

At the very beginning of the Italian project in this site, two main objectives have been especially followed: the publication of the huge amount of data collected during more than 30 years of activity of the French Archaeological Mission and the realization of an Open Air Museum at Melka Kunture.

Fig. 9. Balchit. Particular of a huge accumulation of obsidian blades, flakes and cores.



The publication

The publication of Melka Kunture has been organized at three different levels:

-A small book of "Images", which has been published just one year ago as the result of a detailed photographic survey realized during the second Italian archaeological mission and concerning both the archaeological material stored in Addis Ababa and in Melka, and the natural environment inside the actual protected area of Melka Kunture. The book is also part of the project of the Open Air Museum and it will provide an easy and quick information on Melka Kunture (Bulgarelli & Piperno 2000).

-A "Guide" on the ancient Prehistory of Ethiopia and Melka Kunture has been conceived in order to give deeper and more detailed information of the different sites of Melka Kunture and to explain their cultural meaning in relation with the other most important prehistoric Ethiopian sites. The book was published in Italian, French, English and Ahmaric, and is illustrated with more than two hundred color photographs and drawings (Berthelet *et al.* 2001).

-Finally, the publication of the first monograph on Melka Kunture will be achieved within the half of 2002. It will present contributions on geology, paleontology, paleoanthropology, chronology and archaeology of the Melka Kunture Oldowan sites of Gombore I, Karre, Garba IV and Gombore I (Chavaillon & Piperno 2002).

Part of the book will be devoted to the taphonomic interpretation of the most important sites of Melka Kunture, through the analysis of detailed plans of the paleosurfaces, obtained using a sophisticated computerized GIS approach (see Part II).

The Open Air Museum

The road from Addis Ababa to Butajira in the Shoa Region could be rightly considered a very interesting and unique cultural itinerary.

Worldwide known prehistoric sites such as Melka Kunture as well as evidences such as the megalithic complex of the Tiya stele dating from the 12th to 15th centuries and the recently restored rock-hewn church of Adadi Mariam represent a unique cultural complex not too far from Addis Ababa.

It must be remembered that both Tiya and Adadi Mariam have been considered by the UNESCO as belonging to the common cultural heritage of all mankind and included in the UNESCO's world heritage list. Both the Tiya stelae and the rock church of Adadi Mariam have been recently restored and open to visitors.

The area of Melka Kunture included in the Open Air Museum Project will be transformed into a natural-archaeological Park (the first in Ethiopia) where both the archaeological and environmental features of the site could be exhibited.

The Open Air Museum at Melka Kunture will therefore provide a great opportunity to transform the road to Butajira into a highly interesting and unique cultural itinerary.

The peculiar preservation of the Melka Kunture area is due to the fact that the site has been protected since many years by the Ethiopian Authorities with fences and guardians, providing the preservation of both archaeological sites and natural environment.

Moreover, its proximity to the Awash river has favored the restoration of a unique natural environment along the river itself, which is actually inhabited by several species of birds and small mammals. The original vegetation has been well preserved and contributes to the peculiar beauty of the site along both river sides.

The Open Air Museum Project was officially presented to the Italian and Ethiopian Authorities two years ago. Thanks to economic support of the Italian Ministry of Foreign Affairs, the University of Naples "Federico II" and the ISIAO, it has been possible until now to realize the important restoration of the camp and of the existing small Museum within the protected area of the site.

The project foresees the construction of four buildings in local style in order to present the archaeological, paleontological and paleoanthropological evidences of this site (Fig. 10); the restoration of the road from the Awash village to the camp; the organization of itineraries and picnic areas along the Awash River in order to enjoy not only the archaeological evidences of Melka but also its very important natural environment.

The location of the area for the Open Air Museum have been chosen due to its closeness to the Melka Kunture camp and to the Awash River and considering the archaeological and paleontological interest of the area itself.

The interventions during the 2001 field activity in order to protect the area consisted in the construction of a metal fence surrounding and protecting a roughly pentagonal area of about 10.000 square meters, connected to the Melka Kunture camp with a large path also practicable by cars.

The fenced area comprises a great part of the Gombore locality, where several prehistoric sites, dating from the Oldowan (1.7 my) to the Middle Acheulian (0.7 my), have been identified and some of them also extensively excavated. The sites which will be presented in the Open Air Museum (Gombore II and Gombore II Butchering Site) are related to the Acheulian period:

Gombore II

The Middle Acheulian site of Gombore II, discovered in 1965, extends over more than 1000 m².

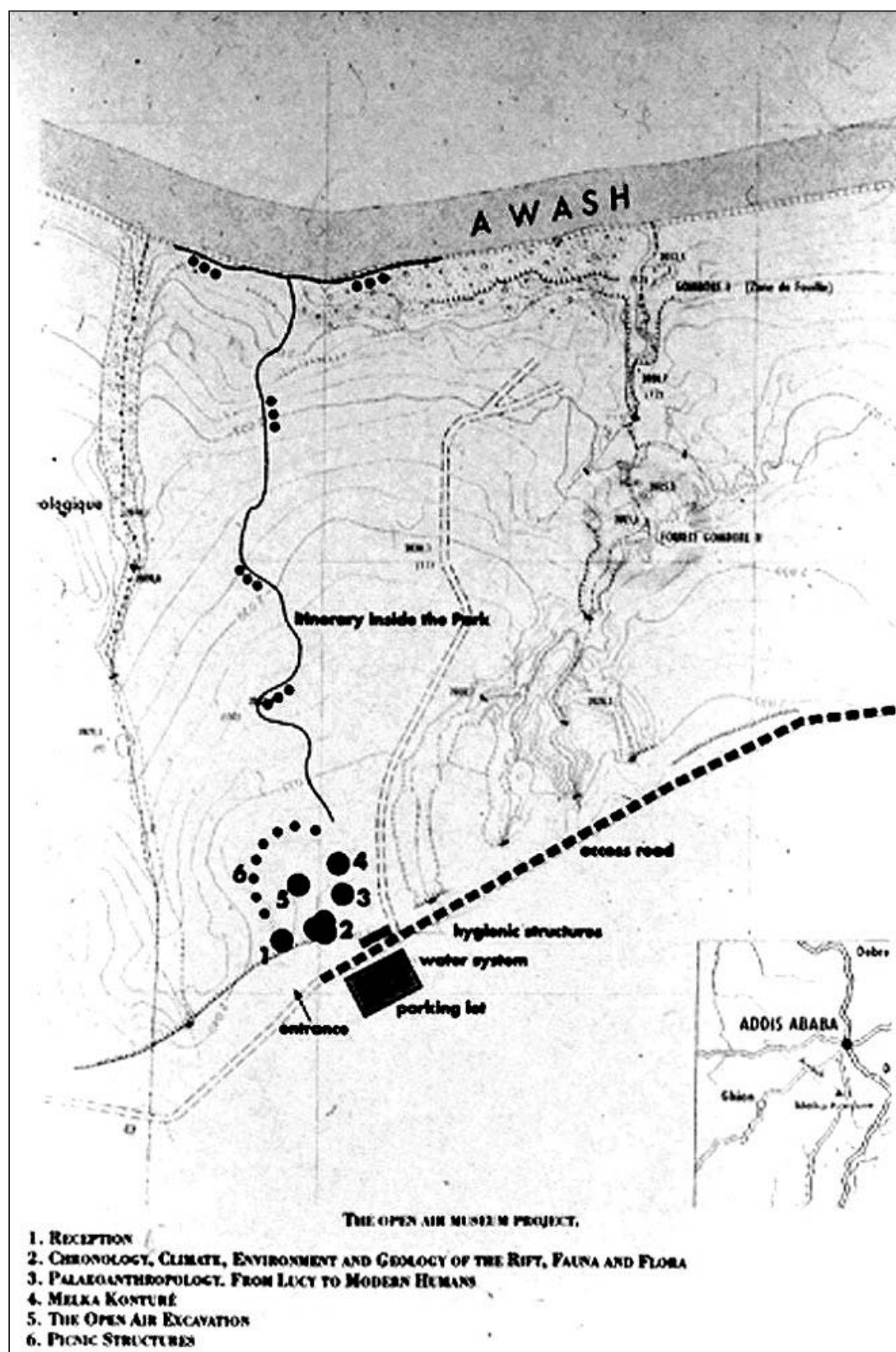


Fig. 10. Melka Kunture. The Project of the Open Air Museum.

The main excavation was carried out at Locality 1, corresponding to a beach of consolidated pebbles lying above a volcanic level (Tuff B), which is dated by Paleomagnetism to around 840,000 years.

A diversified fauna, characterized by frequent remains of Bovids, Giraffes, Hippopotami, Suids, and Equids, including *Stylohipparion* sp. was recovered at this site

The lithic tool kit is made of basalt and obsidian. Handaxes, mainly of obsidian, are carefully manufactured. Their main characteristic, independently from dimensions, is that they often present edges with a twist profile. Cleavers from trachybasalt are rare. Flakes showing a well developed technological level are frequent while tools on flake (side scrapers, end scrapers, borers) are less numerous.

A left parietal of *Homo erectus* was discovered in 1973, while a frontal bone possibly belonging to the same individual was recovered in 1975.

The area definitely prepared for visitors during the 2001 Mission is the Gombore II Butchering Site. More than 250 paleontological remains found during previous excavations have been cast, colored and positioned on the paleosurface (Fig. 11).

In the same area didactic panels with photos and texts both in Amharic and English have been positioned, while some others, with general information on stratigraphy, paleontology and palaeoanthropology of Melka Kunture, were placed near the Museum.

Finally a metal panel, indicating in Amharic, English and Oromo the presence of the prehistoric site of Melka Kunture, was also placed immediately after the bridge crossing the Awash River.

Within the fenced area of Gombore II, the Project foresees the presentation of two excavated areas, after their restoration and consolidation.

**GOMBORE II
AND
GOMBORE II BUTCHERING SITE**
Covering system of excavations and protected area

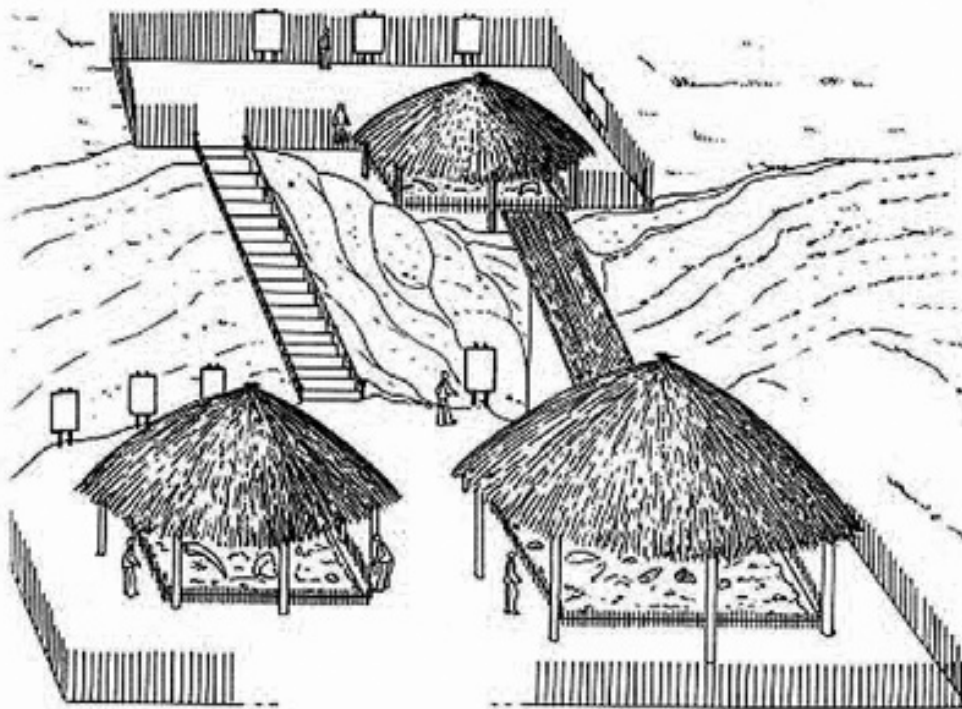


Fig. 11. Melka Kunture. The Gombore II and Gombore II Butchering sites within the area of the Open Air Museum.

Limited excavations carried out during 2001 field research suggested the choose of two areas related to a Middle Acheulian occupation dated to around 800.000 years ago, very rich in archaeological and paleontological remains. Roofs built in local style will protect the excavated areas against animals, rain and wind.

Gombore II Butchering Site

The limited excavation of this site, discovered in 1974, allowed the identification of a possible butchery area of two hippopotami dating to about 700,000 years. This interpretation was confirmed by the 1992 excavation when fragmentary remains of two hippopotami were recovered in association with some lithic artifacts.

The faunal remains, including some vertebrae and ribs, can be attributed to *Hippopotamus amphibius*. The lithic industry is rare: both basalt and obsidian have been used (choppers, polyhedrons, flakes); a basalt handaxe has also been recovered.

Balchit

The extension of this site, the quantity of obsidian accumulations and outcrops, the abundance of flakes, blades and cores make Balchit an extremely interesting site. The locality was included in the Open Air Museum Project and will be presented with casts and original lithic tools in the Open Air Museum at Melka Kunture.

Local development possibilities

The Melka Open Air Museum will provide for the first time the possibility to visit the archaeological site along the year. Its presence could also contribute to the development of the local economy of the Awash village, both ensuring employment to many people during the realization of the Museum and giving the possibility to show and sell local items or gadgets (such as post cards and casts) related to the Prehistory of Ethiopia and Melka Kunture in the village itself and in the Welcome Building.

Local people could also be employed to warrant the efficiency of the buildings, to keep clean the roads and the other structures in the Park itself and to facilitate the visit within the Park.

As well documented in other Open Air Museums built elsewhere in the World, the presence of a Melka Open Air Museum will enlarge the possibility for students and other cultural operators in Addis Ababa to work during the realization of the project as well as for its running.

Masters at the University of Addis Ababa could be organized in order to give the necessary cultural background to students willing to cooperate during the realization and the running of the Melka Open Air Museum.

Training at the National Museum could also be developed in order to guarantee the realization of casts of archaeological and paleoanthropological specimens to be sell at the Melka Open Air Museum.

This long term project could be realized within three years since its starting. The worldwide importance of the prehistoric site of Melka Kunture justifies its realization.

PART II

The intra-site GIS application to the Oldowan sites of Melka Kunture

An important aspect of the research work of the Italian Archaeological Mission over the last few years has been specifically aimed to the study and the taphonomic interpretation of the Oldowan levels of the different sites of Melka Kunture. This involved the use of modern spatial technology (as for example a GIS intra-site) applied to the archaeological excavation (Hodder & Orton 1976; Haining 1994; Djindjian 2001).

Our choice of using a GIS application was determined by the difficulty of organizing thousands of information related to the finds excavated on the different paleosurfaces.

The need to correlate the spatial distribution of evidence with the analytic study of each find makes spatial technology, and especially GIS, very useful in the study of possibly significant associations of artefacts.

A three dimensional GIS application has been also recently proposed for the site of Swartkrans, in order to archive and visualize fossil, artefacts and geological data in their spatial context and to begin to distinguish taphonomic factors responsible for such accumulation (Nigro *et al.* 2001).

Our application of this kind of system was firstly focused on the Developed Oldowan level D of Garba IV, dating to about 1.5 my (D'Andrea *et al.* 2000), and recently also applied to the 1.7 my old Oldowan sites of Gombore I and Karre.

Two main reasons suggested that the site of Garba IV D could adapt itself particularly well to an experiment in the techniques of spatial statistic: the extension of the investigated area (about 100 square meters) and the high number of lithic and faunal remains (over 12,000).

The initial step was to find an application which could perform the following operations:

- a) visualization of all the remains as spatial variables;
- b) realization of thematic maps (faunal remains, basalt and obsidian lithic tools, manuports, etc.),
- c) bidimensional and tridimensional spatial queries (topographical selections, removal of post-depositional noise) in order to reconstruct the post-depositional processes, due to both anthropic and natural events, which led to the formation of the deposit, and the modalities of the different phases of the site occupation;

d) statistic inference of spatial data (spatial correlation and autocorrelation; trend surface analysis) to highlight concentrations and eventually significant associations or relationships between different finds.

To make up for the limitations imposed by “electronic translation”, the logical and physical structure of the application must be accurately planned. Special care has been devoted to plan and create the alphanumeric archives of the application, and to program its vectorial graphics.

The description and organization of informative levels includes no explicit interpretation or explanation of the nature of associations between investigated objects. The most important initial point for the deduction, reconstruction and explanation of the spatial phenomena consists therefore in the structuring of spatial entities and in the description of the associated variables.

The first step in our research was to convert all the data into a digital format, in order to give a structure to the information and to make it compatible with a digital processing.

The existing documentation consisted on the catalogue of the finds written after each year of the excavation, on the plans of the excavated area and on a series of catalogues, in which the typological and technological data of the lithic industry and the paleontological determinations were reported.

These archives were converted into a database allowing a wide range of single or multiple queries capable to group and to count the entire set of data, a fundamental function for statistic analyses.

The next step consisted on the computerisation into a vector format of the original cartography of the plans of the excavated sites. All the remains have been drawn on different plans and represented with different line styles to document overlaying objects on site.

Each object was assigned an exclusive value (or primary key) consisting of its inventory number and the same key provided the link for importing the database.

It is hence possible to interrogate simultaneously both the graphic plans of the finds and the information connected with them in the database. The information of an alphanumeric archive can be visualized in a new data table or in a thematic map. Different types of maps can be produced by visualizing finds on the paleosurface either individually or in association with any other type of information.

Preliminary results and interpretations

The use of a GIS application has proved especially useful in the taphonomic interpretation of specific classes of materials showing significant distributions, allowing us to reach some interesting conclusions on the evidence of Garba IV D.

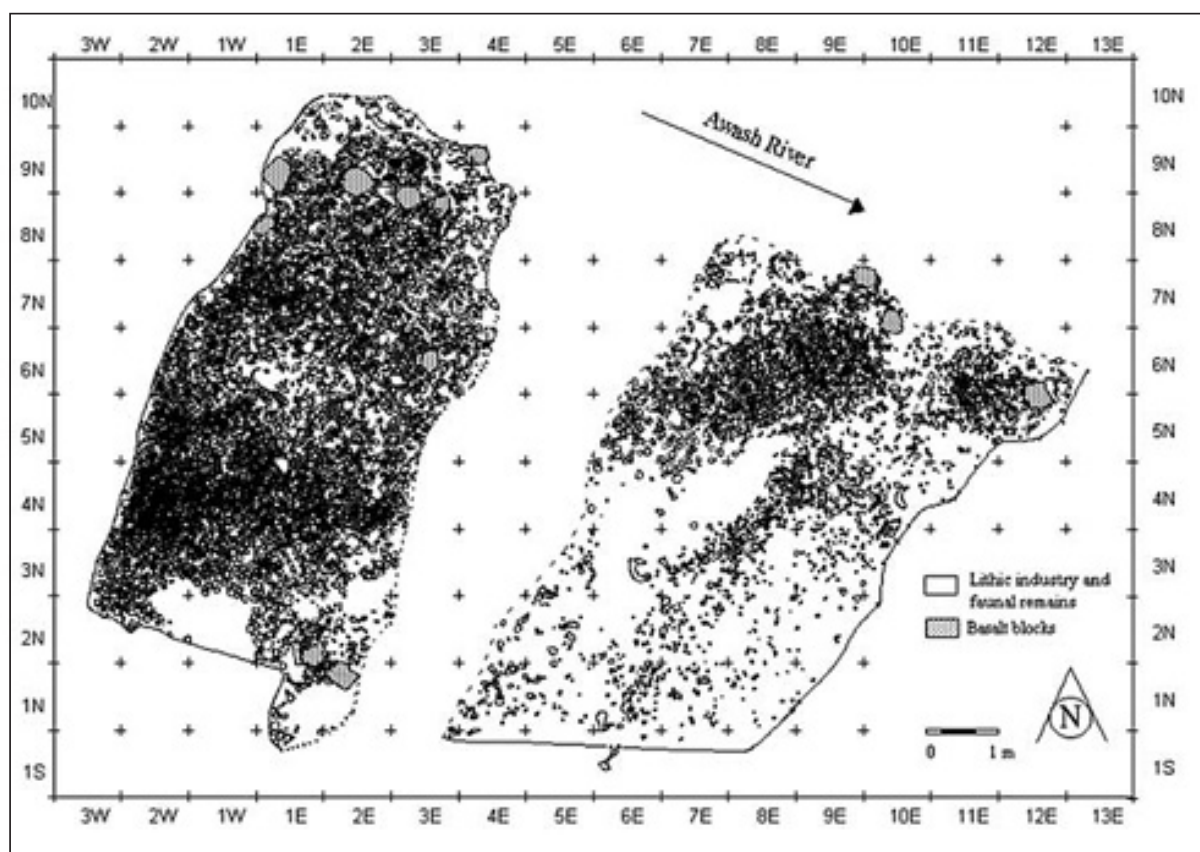
Due to its location close to the right bank of the Awash, the northern part of the site has been destroyed by erosion for an unknown extension, while the excavated area has been divided by a small gully into two sectors (the western and the eastern sectors).

The distribution of the archaeological material on the level D is not uniform. Remains are more intensively accumulated in the western than in the eastern sector of the excavation. High concentrations of materials can be observed in several parts of the excavated area. Two of these concentrations are located in the northern part of the eastern sector, the first one near the eastern bank of the excavation and the second one along a strip about 2.5 m long and 1 m wide, oriented SW/NE. In the western sector, the highest frequency is found in the central part, especially along the western bank, where more than 500 finds are presents in a single square meter (Fig. 12).

Furthermore, the whole paleosurface is strewn with pebbles of basalt and other volcanic rocks, with the exception of obsidian. They do not show any utilization or intentional modification marks, while their distribution approximately corresponds to that of the lithic and faunal remains and they are scattered on the entire thickness of the level. It seems possible to conclude that at least part of them was brought by the hominids and either used as a raw material nearby source for making tools (Fig. 13a) or for some kinds of activities which did not leave any utilization marks on the surface of the pebbles.

An important feature of the site consists on several large blocks of basalt, weighing several tens of kilos each, probably brought here by the hominids.

Fig. 12. Garba IV D. Distribution of the lithic and faunal remains and of the large basalt blocks.



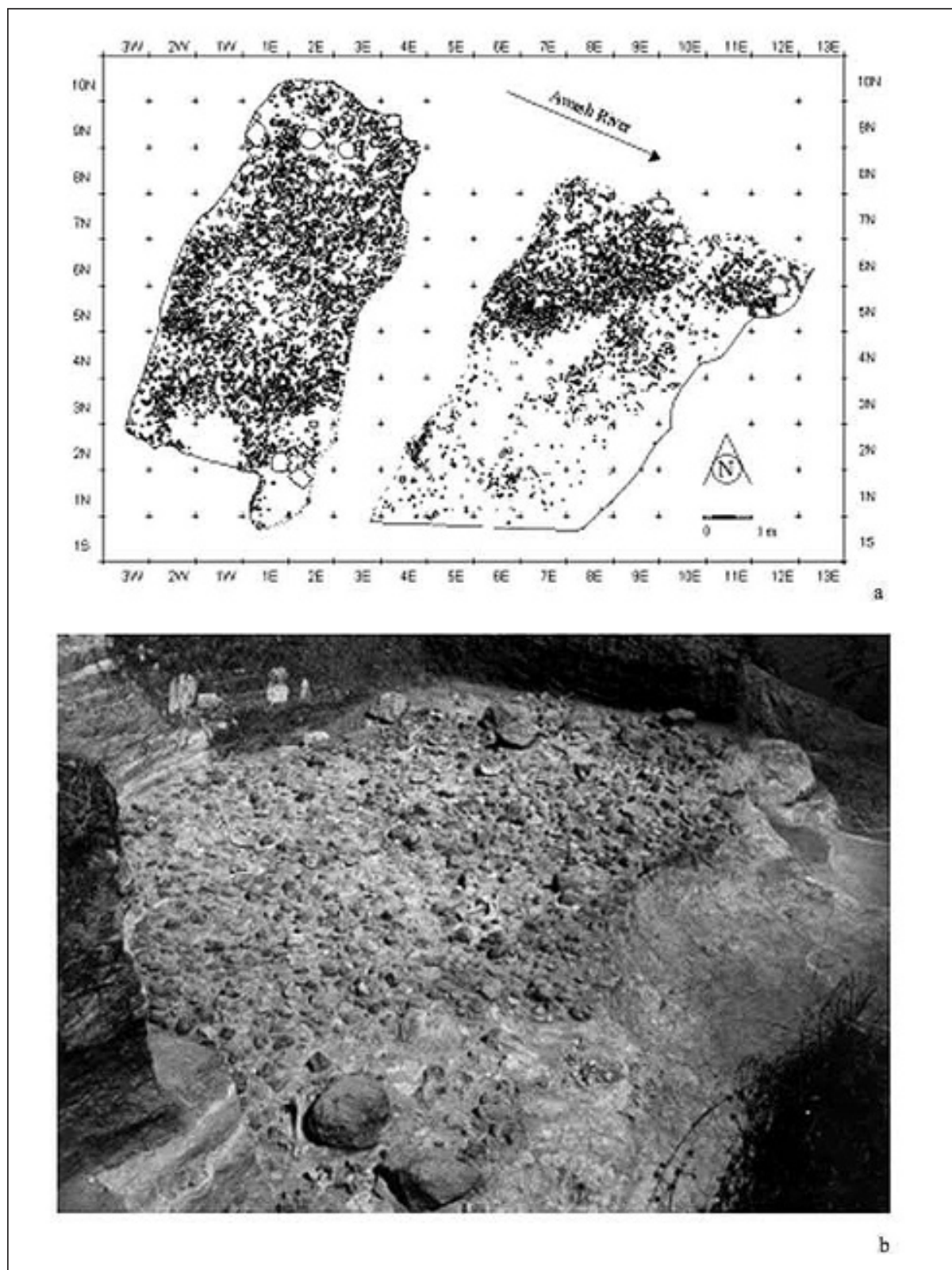


Fig 13. Garba IV D. Distribution of the unmodified pebbles (a); a detail of the western sector (b).

Most of them are located in the northern part of the western sector, two in the southeastern part of the same sector (Fig. 13b), and three of them in the northern part of the eastern sector.

Particular evidence as to their significance could lie in the fact that all the blocks are surrounded by large sized faunal remains such as pelvis, jaws, horns, and large bone fragments (Fig. 14 a, b); on the basis of this recurrent association a possible functional destination of these areas to the sharing of food can only be speculated.

A few areas in both sectors yielded no archaeological and paleontological remains. The most interesting area from a taphonomic point of view is an approximately circular area, large about 1.5 m, close to the southern limit of the excavation in the western sector, completely surrounded by lithic and faunal remains (Fig. 14 c,d). A less distinct area in the eastern sector, measuring about 3 x 1 m, is also partially delimited by lithic tools and fauna. The distribution of the 3,000 faunal remains recovered over the site reiterate the same pattern of the lithic remains (Fig. 15).

Another interesting aspect is the relatively high number of antelope horns (about 100) scattered all over the surface, but with a significant concentration in areas also showing the highest density of obsidian artifacts, near some of the large basalt blocks.

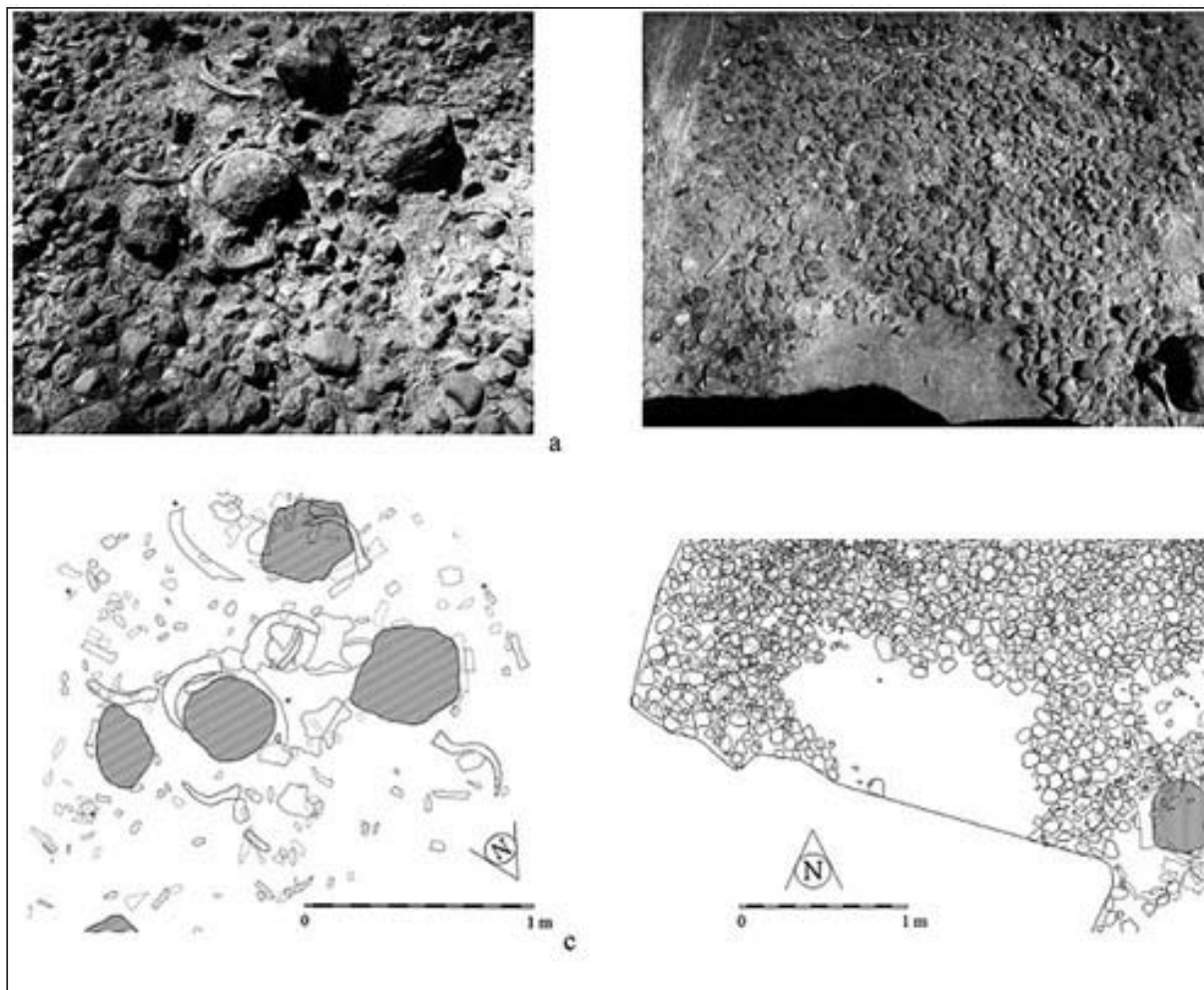
The lithic tools (about 10,000 pieces) as well as the others finds are scattered without significant concentrations (Fig. 16). The high number of objects makes often difficult to interpret the thematic maps. The visualization of the density or dispersion of remains has been simplified by creating frequency maps with objects grouped by value range using SQL (Standard Query Language).

The remains have been grouped and counted by grid square, using either the excavation grid square (1x1 square meters) or smaller squares (50x50 cm²) for more detailed studies of especially significant areas.

The comparison of the total distribution of finds with that of lithic tools on one hand and of faunal remains on the other indicates that the pattern of the spatial distribution of the finds is very similar (Fig 17). But, if we consider the relationship between obsidian tools and basalt ones, it is possible to observe that the density of obsidian in the eastern sector is clearly higher than in the western one, where basalt, tuff, and trachyte prevail (Fig. 18).

It is possible to observe a high concentration in the northern and in the central-western part of the western sector, but, in particular, the distribution seems to indicate that one area in the eastern sector was devoted to the working of this raw material.

Fig 14. Garba IV D. Large basalt blocks surrounded by faunal remains in the northern part of the western sector (a, b); detail of the semicircular area without remains in the southern area of the western sector (c, d).



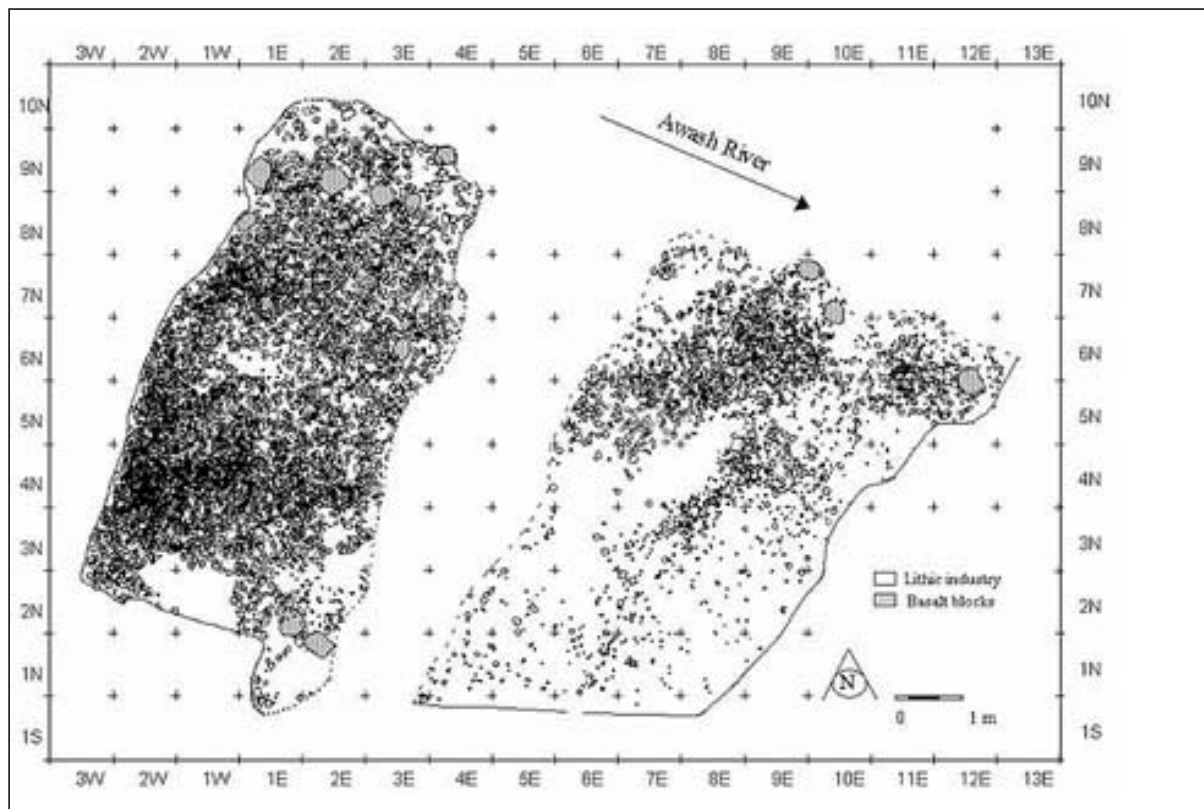


Fig. 15. Garba IV D. Distribution of the faunal remains and of the large basalt blocks.
 Fig. 16. Garba IV D. Distribution of the lithic industry and of the large basalt blocks.

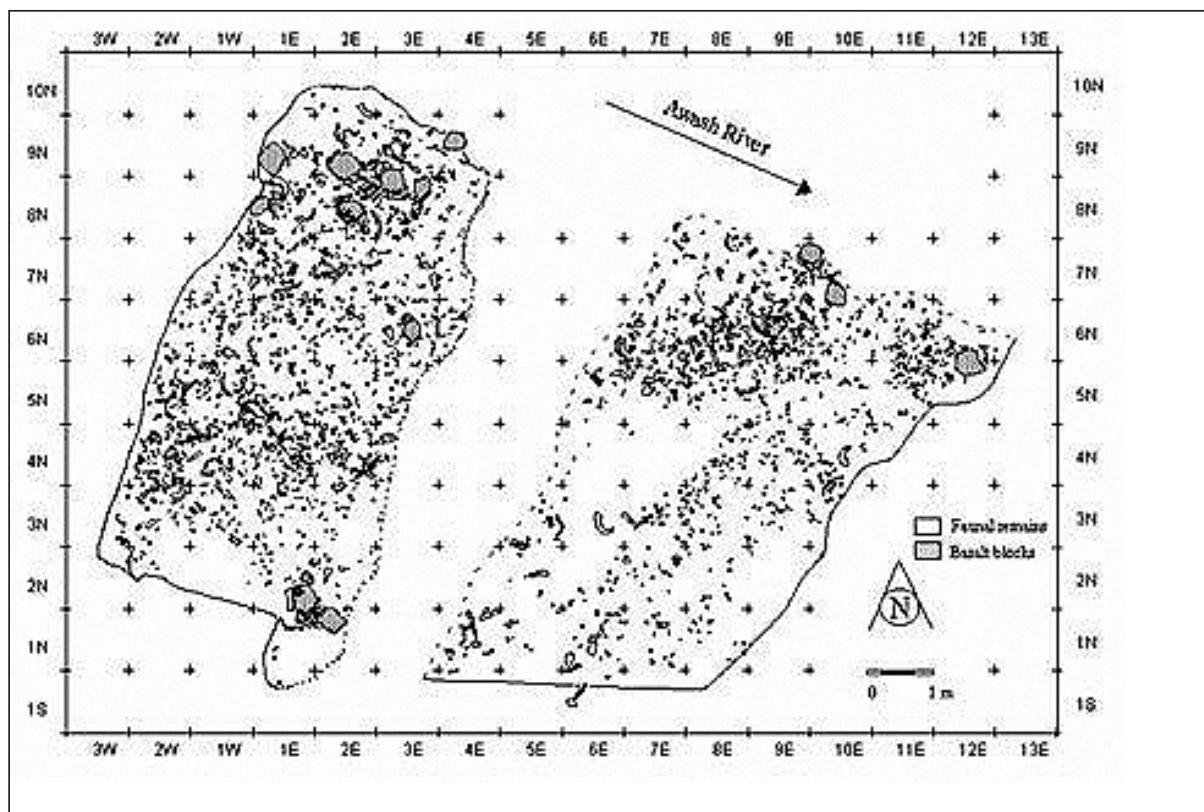


Fig 17. Garba IV D. Frequency of the lithic and faunal remains (a); frequency of the unmodified pebbles (b); frequency of the lithic industry (c); frequency of the faunal remains (d).

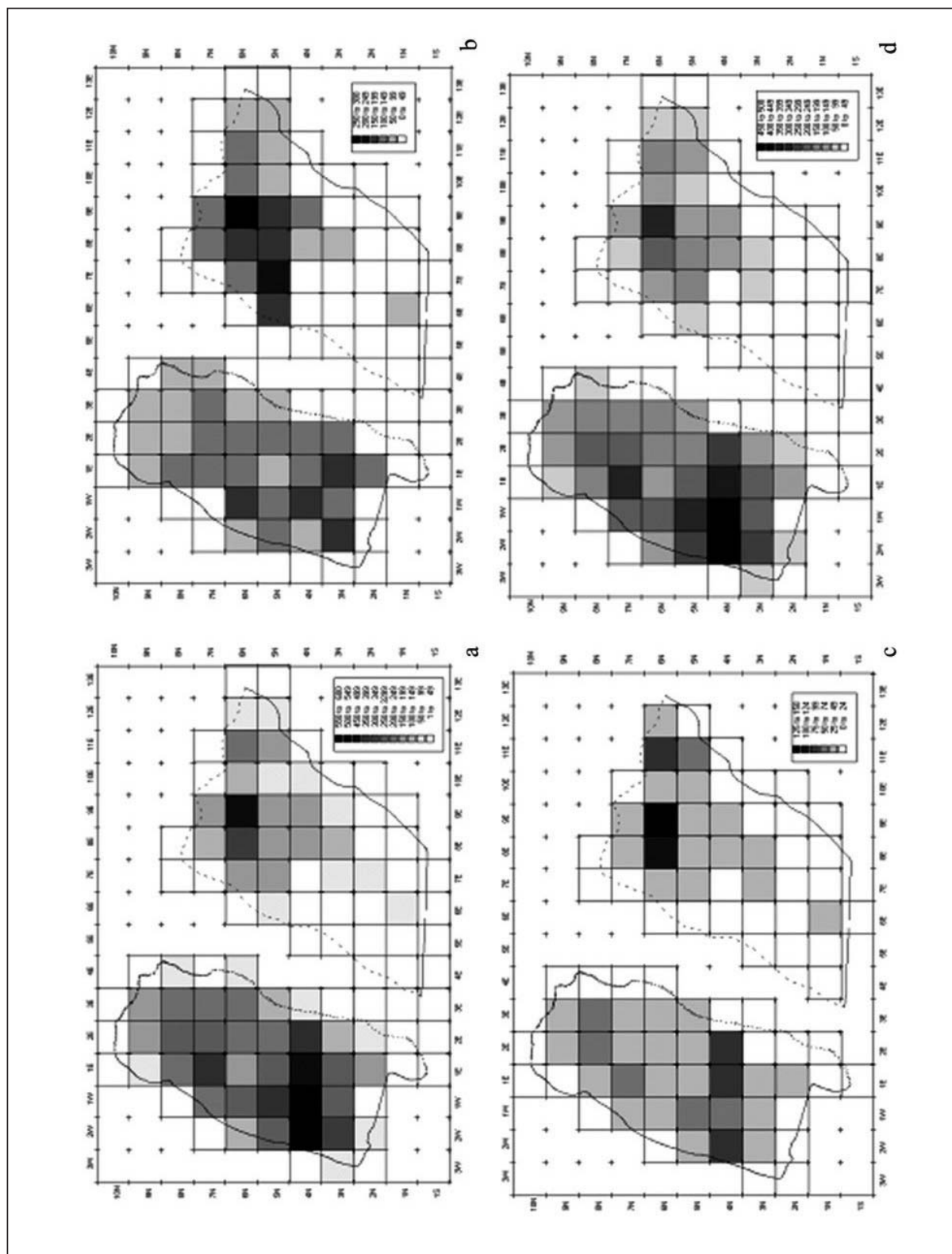
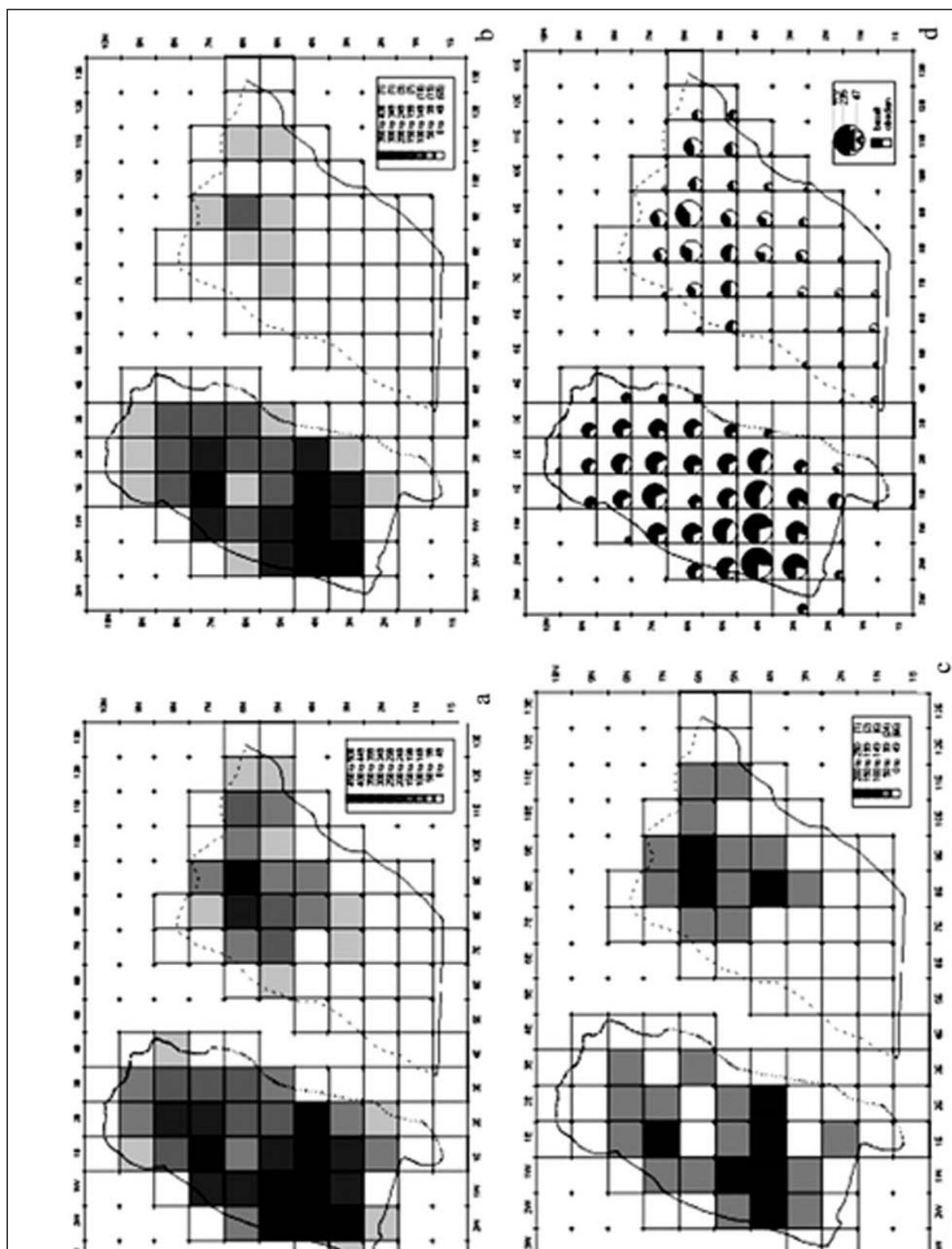


Fig 18. Garba IV D. Frequency of the lithic remains (a); frequency of the basalt industry (b); frequency of the obsidian industry (c); relationship between basalt and obsidian industry (d).



In this area, the density of obsidian wastes, flakes and cores, is much higher than the rest of the paleosurface, and also higher than that of non-obsidian flake and pebble industries within the same area.

Furthermore, there is an evident correlation between high concentrations of fauna and high concentrations of obsidian artifacts, and between high concentrations of basalt pebble tools and high concentrations of basalt flakes (Fig 19). The use of a finer grid (50 cm) brings further confirmation to this observation (Fig. 20).

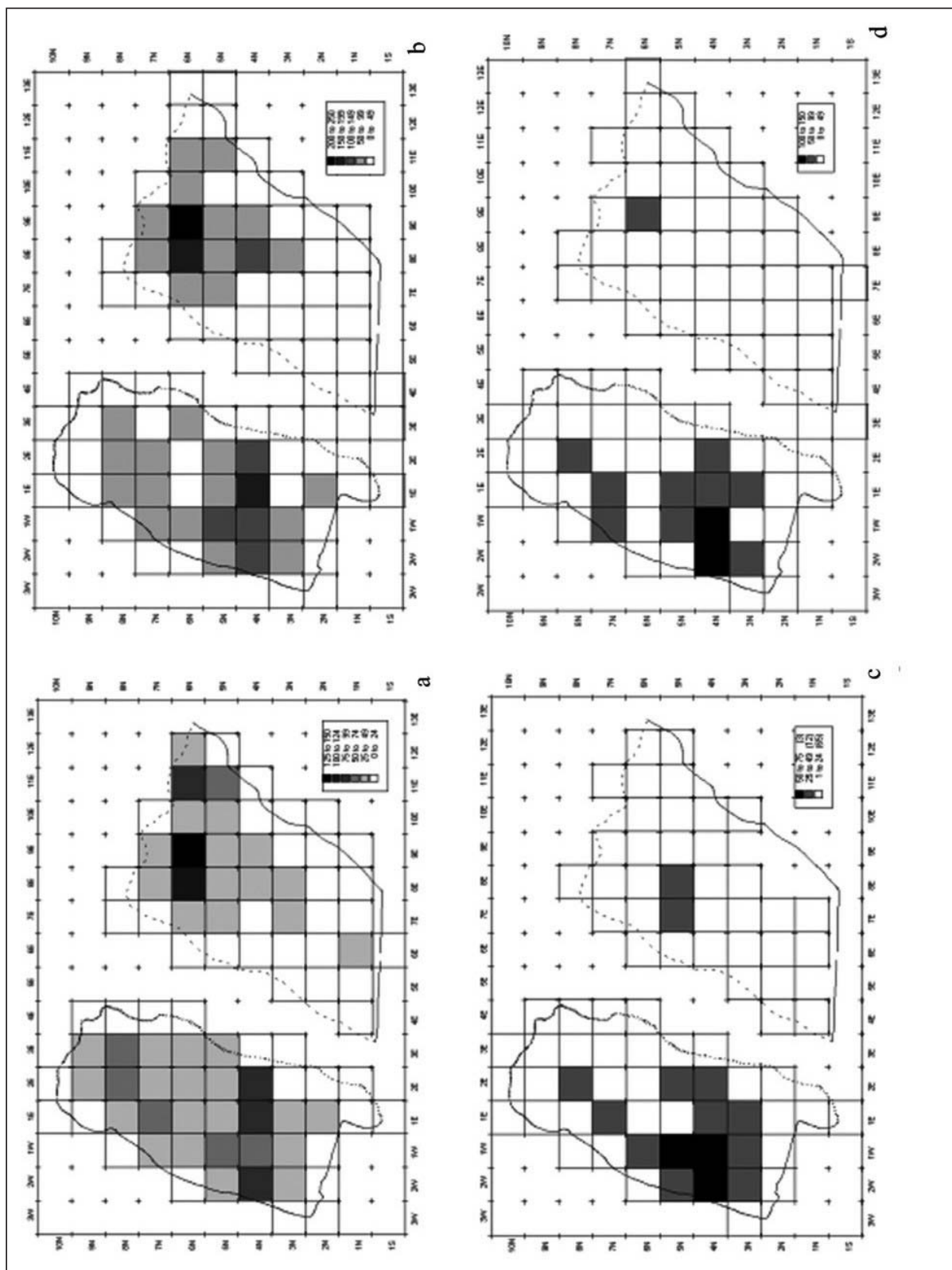
A correlation between the distribution of obsidian artifacts and faunal remains is also perceivable in the north-central portion of the eastern sector, near the basalt blocks surrounded by large faunal remains (Fig. 21a). This is a recurrent association at Garba IV D, which can also be observed in the northern part of the western sector (Fig 21 b).

Further taphonomic investigation of level D at Garba IV was carried out by analyzing the vertical distribution of finds in transversal and longitudinal sections, on which the altitude of all the remains was projected.

The topological functions characterizing GIS allowed the extrapolation of spatial coordinates for each find (x and y); by ranging on the abscissa the values of x or y, respectively, for the transversal and longitudinal sections, and on the ordinate the depth values, it becomes possible to visualize archaeological sections of any portion and over any extension of the excavated area. Each object is represented with a point, because it is impossible to reconstruct the real volume and the real form of the pieces and, as for the plan, it is possible to obtain thematic sections using the information contained in the database.

It is clear that such topological operations will be extremely helpful in reconstructing the modalities and phases of the formation of the site, as well as its post-depositional processes; it is also

Fig 19. Garba IV D. Frequency of the faunal remains (a); frequency of the obsidian flakes, tools and cores (b); frequency of the basalt pebble tools (c); frequency of the basalt flakes and tools on flakes (d).



possible to highlight specific associations or distributions through the interfacing of data from different thematic sections with the horizontal maps.

The thickness of the level D is about 50 cm, with a weak slope from the eastern to the western sector. If we observe the thematic section of the distribution of the lithic industry according to the different kind of raw material, we reach the same conclusions as for the horizontal spatial analysis.

The presence of obsidian in the eastern sector is higher than in the western sector with no particular vertical distribution based on the raw material.

The longitudinal section shows the same distributions. It is interesting to note that the horizontal concentrations correspond to a greater thickness in the section (Fig. 22).

Two main features can be highlighted when considering the lithic industry on the base of raw material and typology: the great accumulation in the central part of the western sector and the higher density of flake industry, above all on obsidian, located in the northern part, where several large basalt blocks are surrounded by faunal remains (Fig. 23).

Fig 20. Garba IV D. Central-northern area of the eastern sector. Frequency of faunal remains (a); frequency of obsidian flakes and tools (b).

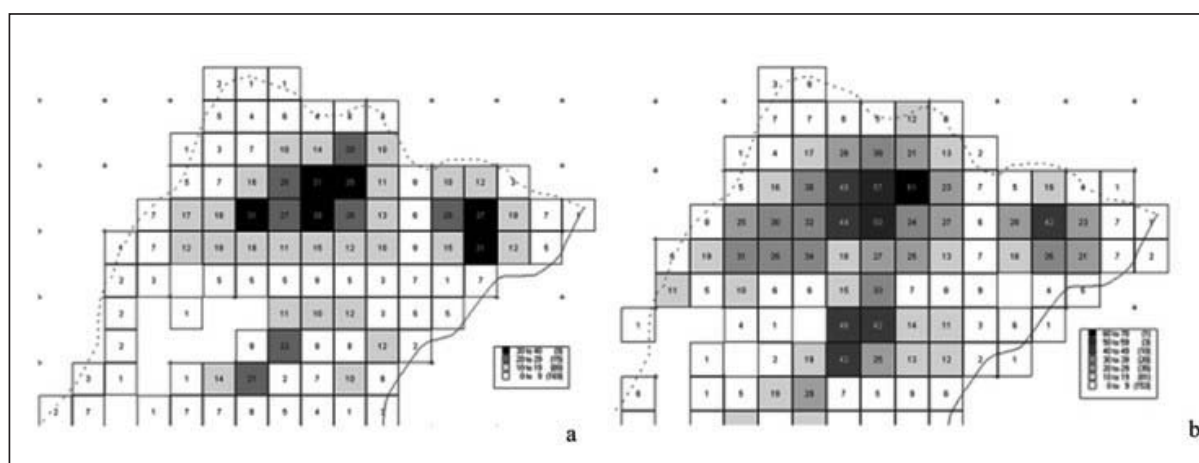




Fig 21. Garba IV D. Distribution of faunal remains, blocks of basalt and obsidian flakes, cores and tools in the eastern (a) and in the western sector (b).

A similar distribution pattern can be observed in the eastern sector with the recurrent association between the large basalt blocks surrounded by faunal remains and obsidian tools and flakes. In the transversal section of the eastern sector this recurrent association is even more evident.

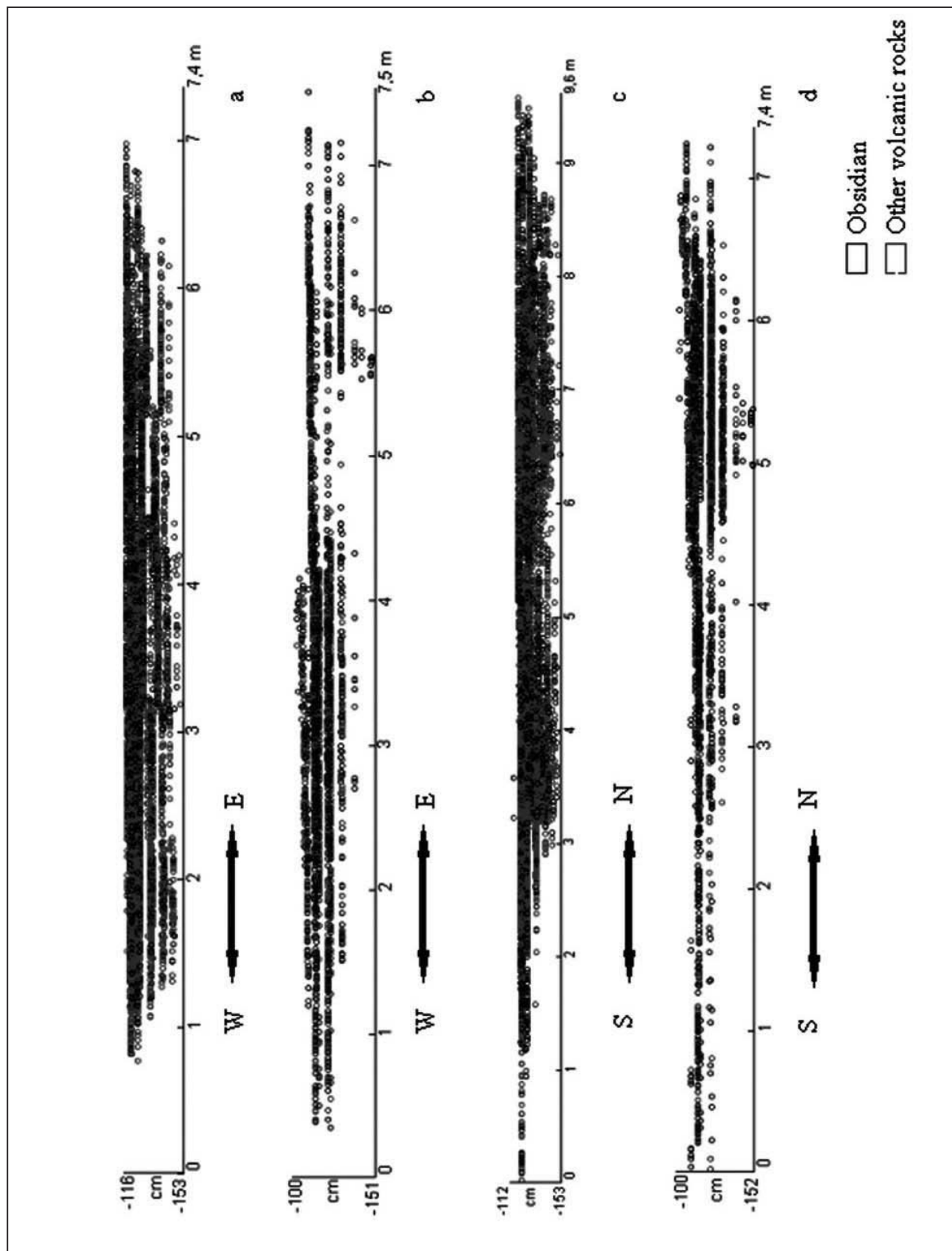


Fig 22. Garba IV D. Distribution of obsidian and other volcanic rocks flakes and tools. Transversal section in the western (a) and in the eastern sector (b); longitudinal section in the western (c) and in the eastern sector (d).

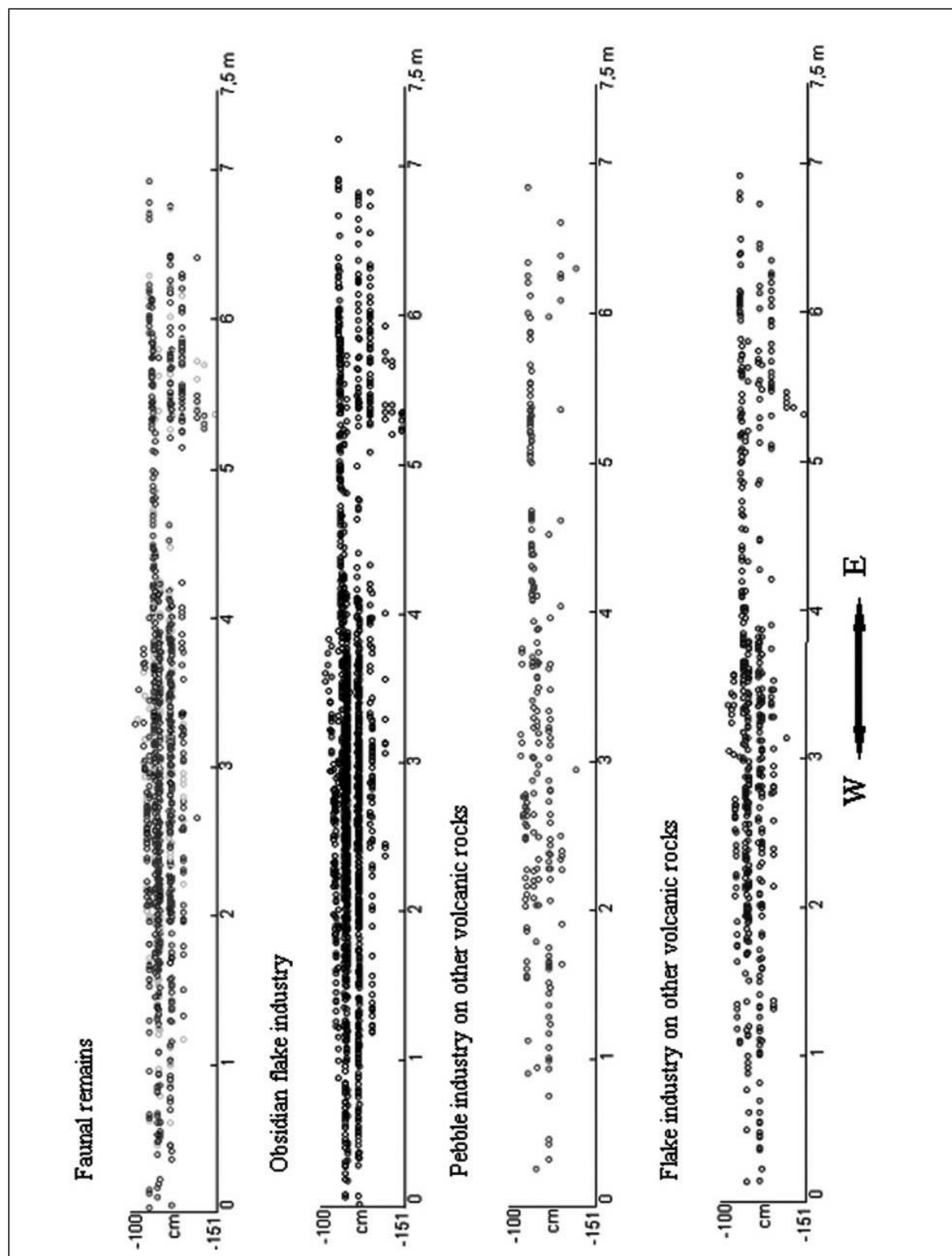


Fig 23. Garba IV D. Transversal section of the eastern sector.

In fact the areas with large basalt blocks, high number of faunal remains and obsidian flake industry, though one close to the other, are nevertheless clearly separated by areas characterized by a low number of remains.

The realization of thematic and general sections is useful not only for the analysis of the associations, but also for the interpretation of eventually distinct phases of frequentation of the site by hominids.

At least three different layers can be distinguished in these sections. In order to confirm this observation, we realized a tridimensional reconstruction of the paleosurface; the use of a vertical exaggeration factor allowed to highlight the vertical distribution of finds. As well as for the plan and section, also for the tridimensional reconstruction it is possible to obtain thematic maps using the information contained in the database.

The next steps of this research will consist in the widening of the analysis of each layer using different methodologies. Thanks to the GIS application, it becomes possible to visualize the horizontal distribution of each layer and to point out to eventual association patterns comparing the results with those obtained until now.

It will also be very helpful to use the refitting method to test if these layers could be eventually correlated to distinct settlement phases. Moreover this method will allow us to give the right weight to the post-depositional processes which led to the formation of these paleosurfaces.

The same system has been actually applied to the other Oldowan sites of Melka Kunture, Gombore I and Karre I, in order to control the results of their interpretation with the taphonomy of Garba IV D. When the data of all these sites will be compared, we could have interesting information about the spatial organization during Oldowan times at Melka Kunture.

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